

Performance-Based Navigation

Introduction

In 2003, the FAA published THE ROADMAP TO PERFORMANCE-BASED NAVIGATION, which publicly announced the strategy to modernize the NAS (US National Airspace System). Performance-based navigation is a general term that defines navigation performance requirements for an air traffic route, instrument procedure, or defined portion of airspace. Performance-based navigation provides a basis for the design and implementation of non-conventional flight paths for airspace design and obstacle clearance. Using this strategy, the FAA intends to address current limitations on air transportation capacity by making more efficient use of the airspace. The FAA continues to work collaboratively with the international community through the efforts of ICAO, Eurocontrol, and the North American Aviation Trilateral; and numerous bilateral partnerships to achieve common requirements and operations. (The Roadmap is consistent with the ICAO Performance-Based Navigation Manual.)

The strategy bases its foundation on two key navigation concepts: RNAV (Area Navigation) and RNP (Required Navigation Performance). It also assures benefit to operators who invest in existing and future capabilities.

RNAV vs. RNP

RNAV systems and their associated operational procedures have been evolving for air transport, regional and corporate aircraft for many years. Most RNAV systems are capable of utilizing navigation signals from various ground and space-based facilities to achieve a high level of position accuracy. Aircraft that have



traditionally been equipped with multi-sensor RNAV systems are referred to as Flight Management Systems. The performance requirements for these systems are defined in specific FAA Advisory Circulars and Technical Standards Orders.

RNP is the latest advancement in RNAV systems evolution. RNP defines the navigation performance level required to operate in a particular airspace or on a designated route (i.e. Enroute, Terminal, or Approach). RNP-approved systems provide the same onboard capability to

conduct traditional RNAV operations. These systems also have the ability to navigate with a much higher degree of accuracy along with the ability for the flight crew to monitor the navigational performance of the system and alert the flight crew if a certain performance requirement is not met. This capability enables operations with reduced obstacle clearance criteria for terminal area procedures as well as closer route spacing - a major contributor to the benefits of performance-based navigation. Figure 1 depicts the general benefits to RNAV and RNP over conventional airspace design, routes and procedures.

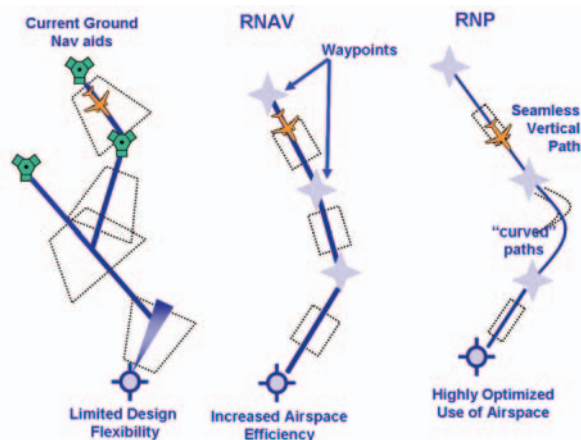


Figure 1 - Airspace Requirements Comparison for Conventional, RNAV, and RNP Operations

RNP SAAAR Procedure Design

RNP capability provides an unprecedented flexibility in construction of approach procedures, resulting in improved efficiency, access, safety and capacity. Conventional approach procedures (VOR, ILS, etc.) use fixed obstacle evaluation areas based on the location and accuracy of the ground-based navigation aids and predefined capabilities of the aircraft's navigation system. RNP SAAAR criteria for obstacle evaluation, however, are flexible and designed to adapt to unique operational environments. They use reduced lateral obstacle evaluation areas and vertical obstacle clearance surfaces based on a RNP value (e.g. RNP 0.3 nm) and may contain curved RF legs (constant radius turns). Aircraft and operators gain authorization to fly these procedures to the specified RNP value through FAA approval and compliance with FAA Advisory Circular 90-101.

Containment Criteria

The concept of RNP is a significant enhancement to airspace use, design and management. The benefits of RNP SAAAR are derived directly from procedure design flexibility, the use of reduced obstacle clearance areas and curved flight paths. RNP procedures are considered "3-Dimensional" as they provide longitudinal, lateral and vertical path deviation information. Conventional procedure design predicated on ground-based

navaids use trapezoidal obstacle clearance areas which increase as a function of the distance from the navaid (navigation accuracy increased as the aircraft came closer to the facility). Whenever obstacles are observed to be within the obstacle clearance area, approach minimums must be raised to ensure clearance from these obstacles.

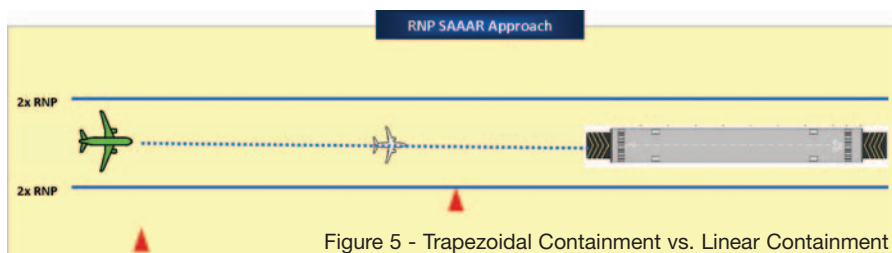
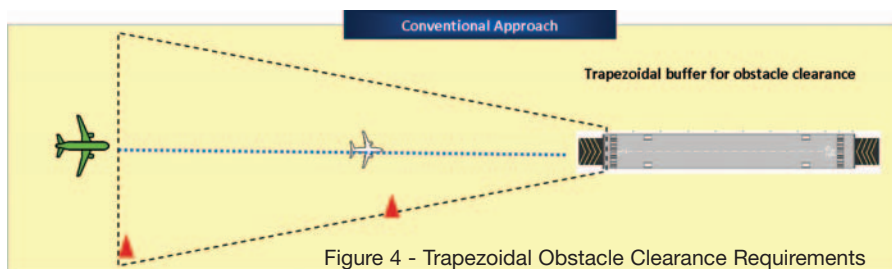
RNP SAAAR procedures rely solely on satellite based navigation (GPS) and, therefore, use linear obstacle evaluation areas for procedure design and determination of approach minimums. For the purpose of procedure design, RNP SAAAR represents the navigation performance required to maintain flight within the obstacle evaluation area associated with the procedure. In general terms, an approach with a specified RNP value means the perpendicular distance between the course centerline and the nearest obstacle must be at least 2X the RNP value specified for the approach. For example, an approach with an RNP value of 0.3 means that the closest obstacle perpendicular to the course centerline must be no closer than 0.6 NM away. The result is a lower approach minimum because obstacles that were previously considered using the trapezoidal method are no longer a factor when using linear containment criteria specified for RNP SAAAR.

Aircraft Equipment

In order to fully realize the benefits of RNP and to comply with federal regulations, airframe manufacturers rely on Honeywell's advanced avionics to provide the guidance required for RNP SAAAR operations. Honeywell's flight management systems incorporate highly accurate GPS and IRS information to safely guide aircraft through any approved RNP SAAAR procedure. A validated navigation database allows the FMS to read the approach designer's aircraft guidance along the approach path as well as the missed approach procedure, if necessary. In addition to the high level of navigation accuracy, the Enhanced Ground Proximity Warning System monitors the aircraft position and flight path to provide an extra level of safety. These technologies allow the operator to conduct RNP approaches to the high standards required for SAAAR operations.

Flight Crew Operational Approval

In addition to aircraft equipment requirements, flight crews must be properly trained and qualified in order to fly RNP SAAAR approaches. It is necessary to revise SOPs (Standard Operating Procedures) and checklists in order to provide pilots sufficient guidance to conduct RNP SAAAR operations. Typically, this guidance is developed in accordance with recommended policies and procedures provided by the OEM.



Benefits of RNP SAAAR

The operational benefits to RNP SAAAR are numerous. A few examples of these benefits are:

- Increased operational efficiency
- Lower approach minimums
- More reliable, repeatable flight paths

Improved Runway Capacity/Efficiency

With today's separation standards for simultaneous runway operations, traffic flow is constricted. As RNP SAAAR procedures proliferate into the national airspace system, the application to operations involving parallel and converging runways and adjacent airports will prove extremely beneficial in reducing airspace congestion.

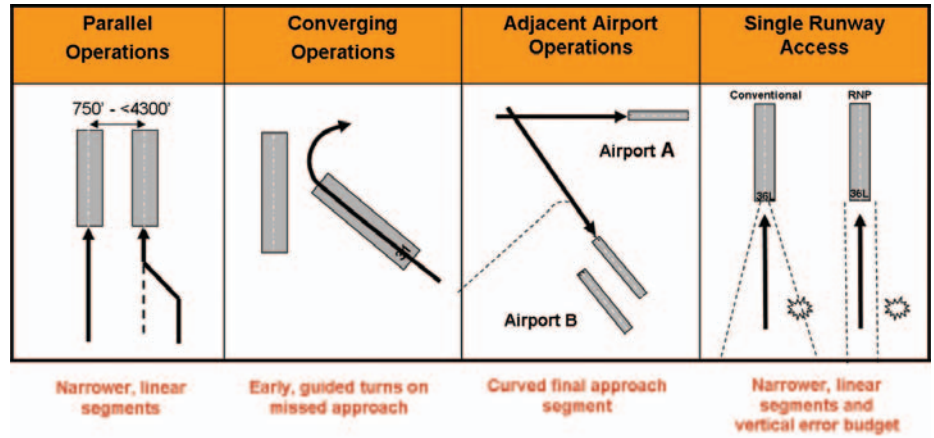


Figure 2 - Benefits of RNP SAAAR Approaches for Parallel, Converging, and Adjacent Runways

Improved Flight Efficiency

The ability to design and fly highly accurate and repeatable flight tracks with constant radius turns presents an opportunity to greatly increase operational efficiency in numerous areas. Procedures based on

circuitous flight paths because of terrain and/or airspace may be optimized utilizing more direct routings to the runway, saving time and fuel.

Lower Approach Minimums

RNP SAAAR approaches will provide access to terrain-challenged airports which were limited by high minimums or lack of precision instrument approaches.

A comparison of the minimums at Palm Springs for the conventional vs. the RNP SAAAR approach is shown in figure 3.

RNP SAAAR procedures also offer a wide array of safety enhancements.

- Vertical guidance (VNAV) is available to the runway end. This provides flight crews with better situational awareness, especially at night or in mountainous terrain.

- Curved approach (and missed approach) segments to avoid obstacles – Lateral guidance using RF legs increases situational awareness and ensures obstacle clearance.
- System monitoring and alerting – A required component of RNP SAAAR is the ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify to the flight crew whether the operational requirement is or is not being met during an operation. This navigation system offers great benefits where terrain, traffic or complicated procedures exist today.

CATEGORY	A	B	C	D
CIRCLING	2300-1¼ 1826 (1900-1¼)	2300-1½ 1826 (1900-1½)	2300-3	1826 (1900-3)

33°50'N-116°30'W

PALM SPRINGS INTL (PSP)
VOR or GPS-B

CATEGORY	A	B	C	D
RNP 0.17 DA		728-1	277 (300-1)	
RNP 0.3 DA		859-1½	408 (400-1½)	
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED				

33°50'N-116°30'W

PALM SPRINGS INTL (PSP)
RNAV (RNP) Z RWY 13R

Figure 3 - Approach Minimums Comparison for Palm Springs Conventional vs. RNP SAAAR

Honeywell Go Direct Services

Due to the complexity of RNP SAAAR operations and certification challenges, the FAA has emphasized that a high level of oversight is required. As a result, the FAA has solicited a call for RNP consultants. Honeywell received FAA designation as a Consultant for RNP SAAAR operational approvals in November 2007. In order to meet the needs of operators and aircraft manufacturers to implement this technology, Honeywell is offering a suite of services and tools related to RNP SAAAR.

Overview of Honeywell Go Direct Services to Operators:

The FAA RNP Consultant designation positions Honeywell to effectively assist operators with the RNP SAAAR operational approval process. Further, Honeywell is offering customers a full line of RNP related services including: Navigation database validation, RNP monitoring, RNP prediction services. These added services will enhance efficiency of RNP SAAAR operations for corporate operators.

Go Direct services includes the following services to help operators develop and implement a robust RNP SAAAR program in full compliance with AC 90-101, resulting in timely FAA operational approval:

1. RNP SAAAR Consultancy to assist operators with the RNP SAAAR approval process to comply with the AC 90-101. The consultancy team will assist operators with the following:
 - Technical expertise and guidance for every operational requirement in the AC 90-101
 - Established relationships with FAA
 - Dedicated team of consultants
 - RNP SAAAR gap analysis of operator's current processes and documentation
 - Standardized application package and FAA approval recommendation
 - Reduced timeline for approval
2. Navigation Database Validation to comply with the requirements of Appendix 3 of AC 90-101.

- The DB validation process will be synchronized with the Navigation Data production process to ensure that the procedures are validated in-cycle for each new database.
 - The DB validation process includes,
 - A Visual comparison of the source database to the FAA 8260
 - Flyability validation through use of Honeywell FMS simulators
 - Evaluation of nuisance EGPWS warnings
 - Provide letter to operator that lists all validated RNP procedures in compliance of AC 90-101
3. RNP Monitoring Program that provides record keeping of all operator's RNP operations. As per AC 90-101 requirements every 30 days a written report will be sent to the FAA with details of all operations and a technical review of results. The operator will be provided Blackberry and web-based templates to facilitate the record keeping.
 4. RNP SAAAR Training: Honeywell is working with Training providers to develop RNP SAAAR training programs that comply with the AC 90-101.
 5. RNP Prediction Tool that provides a detailed assessment of RNP availability for the entire route of flight. This tool is expected to be available in 2009.

Overview of Honeywell RNP SAAAR Services to Aircraft Manufacturer:

Honeywell will offer the following services to the Aircraft manufacturer to enable aircraft certification for RNP SAAAR in accordance with Appendix 2 of AC 90-101.

- Regulatory expertise to interpret Appendix 2 of AC 90-101
- Compliance matrix for Appendix 2
- Recommendations for detailed Operational consideration (Appendix 4) material
- Recommendations for revisions to maintenance manual and minimum equipment list

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